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Impact of Climate change on Agricultural Production and Impact of Climate Change in Meerut Division

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ORIGINAL ARTICLE

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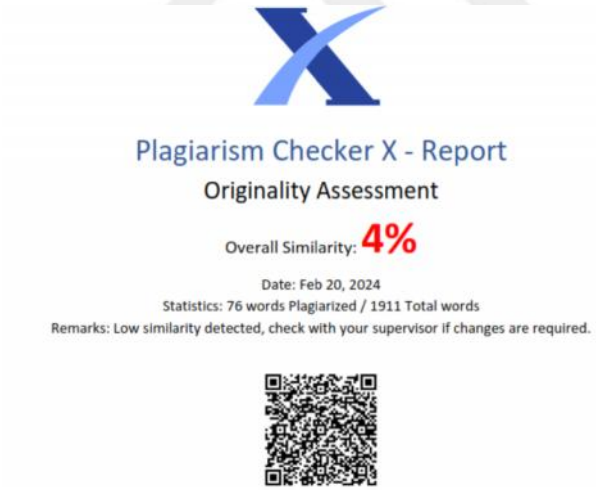


ABSTRACT

Weather-related events have a significant impact on agricultural production, hence any change in the climate will have a significant impact on crop output and productivity. The Meerut Division in Uttar Pradesh may see a 1.0 to 1.1% per ha decline in agricultural productivity by 2020, according to research using NYD analysis to estimate crop yield on a seasonal basis. In a similar vein, in Western Uttar Pradesh, the lowest temperature may cause a 1.5–1.9% per hac. reduction in the production of Kharif Crops. The south-west monsoonal rainfall was found to be the main element influencing how much Kharif Crops will yield, according to the predicted rainfall forecast. Compared to other states that produce wheat, Uttar Pradesh has a greater impact on wheat production in terms of maximum temperature. By the end of 2080, an increase in the maximum temperature is expected to cause a 5% to 6% percent loss in wheat output in Uttar Pradesh, compared to a 1.5- to 2.0-percent decline in other states.

KEY WORDS

Climate change, Agriculture, Rainfall, Rice, Global warming.

INTRODUCTION

A significant danger to the nation's conservation efforts is usually cited as climate change. Recent studies demonstrate that it is feasible to identify the impacts of a changing climate on biological systems. The Earth's climate has already warmed by 0.5° C during the previous century. Around the world, there is evidence of recent climatic change at every level of ecological organization, population structure, and ecosystem function.

The significance of climate change as an ongoing danger to species highlights the necessity of conservation and reintroduction initiatives. Major climatic factors influencing the nutritional strategy of animals through the amount of crop and pasture production include temperature, humidity, air movement, sun radiation, and rainfall. Natural calamities brought on by a changing climate, such as drought, cyclones, and irregular and unequal rainfall, have become a significant obstacle to increasing India's agricultural output in the last ten years. According to the IPCC (IPCC, 2001), the average daily rainfall during the summer monsoon in India might decline by 0.5 mm. The IPCC has collated the scope of anticipated future changes in temperature, precipitation, and carbon dioxide for several regions of the world, including India (Watson et al., 2016). By 2020, CO2 levels may rise from their present level of around 397 ppm to between 413 and 421 ppm, according to this. By 2070, it's probable that this will rise even more to 605-755 ppm. The expected amount of change in rainfall and temperature for India (Table 1) is subject to significant uncertainty. In comparison to Rabi, the Kharif season's temperature increase is predicted to be smaller. However, the rainfall during Ramadan displays greater ambiguity. There may be a 10% rise in rainfall during the Kharif season. By 2030, it is anticipated that the research area's annual mean warming will have increased by 1.4 to 1.8° C, and by 2050, it will have increased by 2.23 to 2.87° C. According to Aggarwal et al. (2021), rainfall patterns for the Kharif and Rabi seasons are expected to change little.

Table 1: Expected changes in weather parameters in Uttar Pradesh (Meerut Division) by 2010 and 2080 A.D. due toglobal warming

Parameter	Rabi		Kharif	
	2010-2020	**2070-80**	**2010-2020**	**2070-80**
Temperature increase (°C)	0.4 to 0.8	0.1 to 0.5	0.1 to 0.5	0.5 to 2.23
	397 to 424	605 to 785	397 to 424	605 to 785
Rainfall change in south west monsoon region (%)	0	-11 to +11	0	-11 to +11

*(**Source :** Comparative Data form Watson et al., 2016)*

Data and Methodology

Sampling Design

Weather data from various stations in India (Western Uttar Pradesh) for the past 30 years (1986-2015) including maximum temperature, minimum temperature, relative humidity, wind direction, total evaporation, and bright sunshine hours were gathered from India Meteorological Department. The Departments of Revenue, Statistics, and Directorate of Agriculture of the respective State were also contacted for information on the area, production, and productivity data of the primary crops grown in the selected district as well as the other meteorological factors listed above.

Model Used

HadCM3 model (HadCM3 stands for the Hadley Centre Coupled Model version 3).

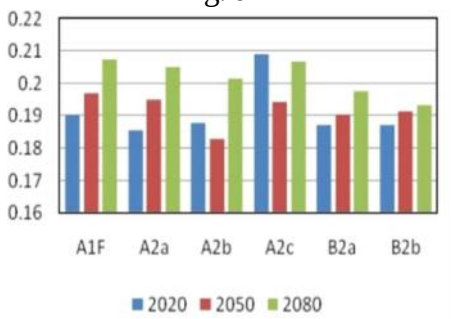
Tools of Data Collection

It was developed in 1999 and was the first unified model climate configuration not to require flux adjustments, artificial adjustments applied to climate model simulations to prevent them drifting into unrealistic climate states.) was used to predict the Normalized Yield Difference (NYD) analysis of the future crop yield scenario on a seasonal basis. Variability in rainfall amounts was examined using a statistical model with five parameter averages, including air temperature (°C), relative humidity (%), wind direction (degree), total evaporation (mm), and bright sun shine duration (hrs).

Analysis and Interpretations

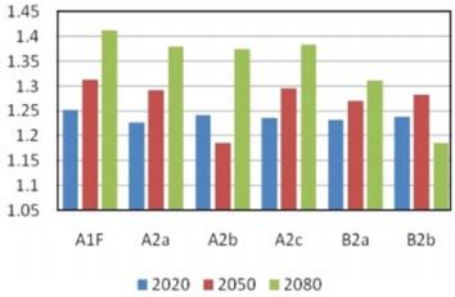
Climate Change Impact on Agriculture in Western Uttar Pradesh

Fig. 01



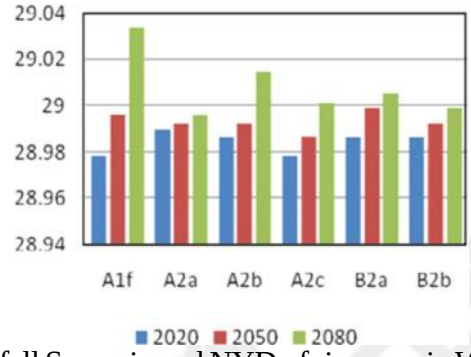
Tmax (Seasonal) Scenario and NYD of rice crop in W.U.P.

Fig. 02



Tmin (Seasonal) Scenario and NYD of rice crop in W.U.P

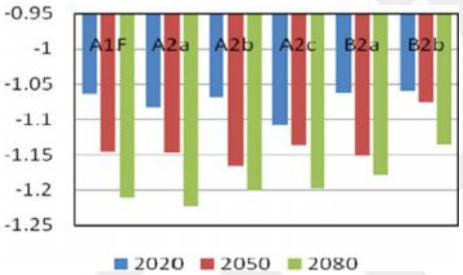
Fig. 03



Rainfall Scenario and NYD of rice crop in W.U.P.

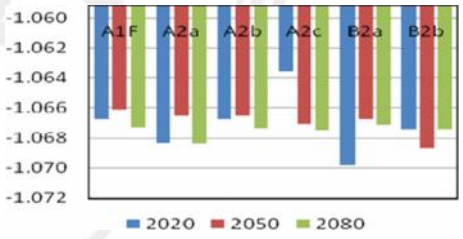
Figs. (1-3). Prediction of Normalized Yield difference (NYD) in Western Uttar Pradesh of rice crop.

Fig. 04



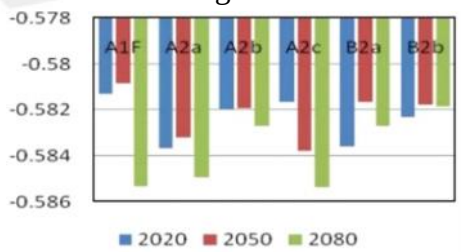
Tmax (Seasonal) Scenario and NYD of wheat crop in W.U.P

Fig. 05



Tmin (Seasonal) Scenario and NYD of wheat crop in W.U.P.

Fig. 06



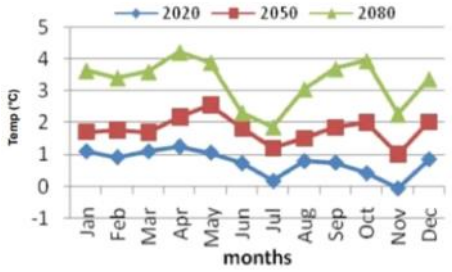
Rainfall (Seasonal) Scenario and NYD of wheat crop in W.U.P.

Figs. (4-6). Prediction of Normalized Yield difference (NYD) in Western Uttar Pradesh of Wheat crop.

- In the Fig. 1 to Fig. 6, X-axis represents different seasons (A1F, A2a, etc.) and Y-axis, the value in %.
- A1F stands for annual average of the entire year.
- A2a stands for Pre monsoon season of particular year.
- A2b stands for monsoon season of particular year.
- A2c stands for post monsoon season of particular year.
- B2a stands for winter season of particular year.
- B2b stands for summer season of particular year.

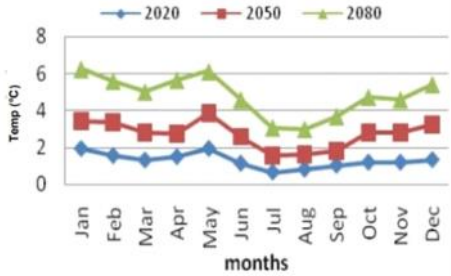
Climate Change Impact on Agriculture in Western Uttar Pradesh

Fig. 07



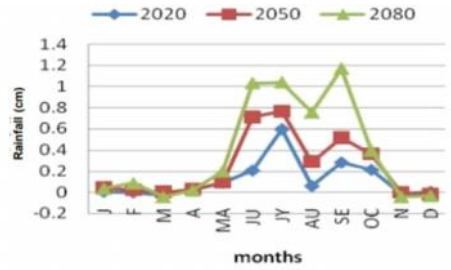
T.Max. of W.U.P.

Fig. 08



T.Min. of W.U.P.

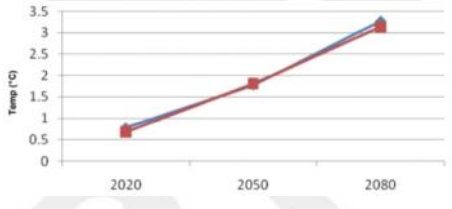
Fig. 09



Rainfall Pattern of W.U.P.

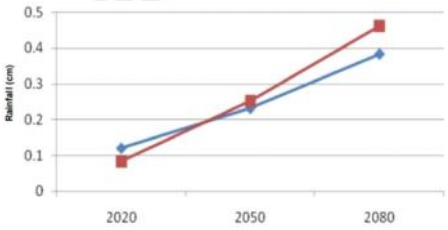
Figs. (7-9). Future prediction of Tmax./ Tmin. and rainfall for Western U.P

Fig. 10



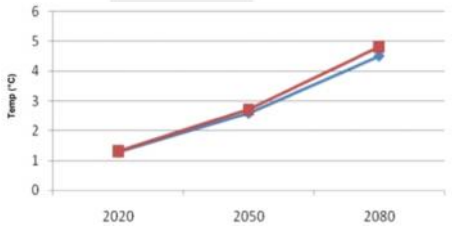
Trend of T.Max in W.U.P.

Fig. 11



Trend of T.Min in W.U.P.

Fig. 12



Trend of Rainfall in W.U.P.

Meerut Division
Western Uttar Pradesh

Figs. (10-12). Trend scenario of weather in Western Uttar Pradesh and Meerut Division.

Results and Discussion

Crops and Weather

It has been found that using NYD analysis to estimate crop output on a seasonal basis, increases in maximum temperature may result in a drop in rice yield in Wester Uttar Pradesh of 1.0 to 1.1% per hectare by 2020 (Fig.1). In Western Uttar Pradesh, a minimal temperature fluctuation may reduce the production of rice by 1.5 to 1.9% per hectare (Fig. 2). According to a rainfall projection for the future, the south-west monsoon will continue to play a significant role in regulating rice production (Fig. 3). In contrast to Western Uttar Pradesh has a more substantial impact on wheat productivity in terms of maximum temperature.

By the end of 2080, increases in the maximum temperature alone are anticipated to cause a 5–6% decline in wheat output in Meerut Division, compared to a 1.5–2% decrease in Western Uttar Pradesh (Fig. 4). Aggarwal and Sinha, 1993, also came to the same conclusions. In a similar vein, has a greater impact of lowest temperature on predicted yield than does Western Uttar Pradesh (1-2%) (Fig. 5). Rainfall in the Rabi season in the Western U.P. in the future is not expected to have a substantial impact on wheat crop output (Fig. 6). In general, it is estimated that the rate of growth of the maximum temperature in Western Uttar Pradesh will be larger during the years 2050 to 2080 (2-4° C) than it would be during the years 2020 to 2050 (1-2° C) (Fig. 10). According to Fig. 11, Uttar Pradesh would get less rainfall in the decade 2020 than the Western U.P., but the tendency will change in the decades 2050 to 2080.

Similar forecasts were also produced for variations in minimum temperatures, although with larger magnitudes in Western Uttar Pradesh, ranging between 3-5° C in later this century as opposed to early (2-3° C) (Fig. 12). In contrast to the usual tendency, it is predicted that December and January would be hotter in Western Uttar Pradesh than November (Figs. 7, 8). The projected rainfall across Western Uttar Pradesh from 2020 to 2080 shows that rainfall would rise throughout the south-west monsoon season, but August might see a severe reduction in precipitation in all of the scenarios (Fig. 9). In a similar vein, temperatures in August might be lower than average (both maximum and minimum in all months of the year).

Western Uttar Pradesh saw two estimated rainfall maxima during the Kharif season, with the primary peak occurring in July and the secondary high occurring in September. It was also predicted that August will experience an intermittent drought due to a sharp decline in rainfall. The secondary peak of rainfall in September is predicted to result in a considerable reduction in the terminal drought as well. In Uttar Pradesh specially Meerut division, it was predicted that the primary peak of rainfall would occur in June rather than July or August, while the secondary peak would occur in October. Maximum and minimum temperature trends in Western Uttar Pradesh indicate an upward tendency. However the lowest temperature trend in Meerut division was only projected to slightly rise from 2080 to 2085.

Western Uttar Pradesh experienced terminal drought 70% of the time (1970–2003), although current trends in drought indicate that early and intermittent droughts are occurring more frequently. As opposed to early stage drought, which is 23%, terminal drought might reduce rice output in Western Uttar Pradesh by a factor of 44% (Kumar et al., 2006).

Climate, Ciological, and Physical Production Potential and Limitations

The two main cereal crops grown in Uttar Pradesh are wheat and rice. While rice was grown on 59.25 lakh hectares in 2006 with a total production of 150.6 lakh metric tonnes at an average productivity level of 2.3 tonnes per hectare, the state produced 235.7 lakh metric tonnes of wheat from an area of 91.85 lakh hectare during the 2005–06 growing season. (Agricultural Production in Uttar Pradesh, 2005–2006. Due to the following limitations, there is a significant difference in the production levels of wheat and rice in Western Uttar Pradesh:

1. More than 90% of the overall rice-growing area is rainfed. The frequency of floods in Western Uttar Pradesh are growing significantly, which has a significant impact on crop yield, as a result of irregular

rainfall and unequal distribution. Therefore, due to complicated ecological conditions characterized by periodic floods and droughts, rice cultivation in Meerut Division is particularly fragile and risky (Aggarwal and Mall, 2002).

2. Abiotic stress is one of the main factors limiting the productivity of wheat crops. One factor identified as a productivity restriction for wheat crops is high temperature during the reproductive period (Fangmeier et al. 1999).
3. In Meerut Division, there is a yield gap between what can be produced and farm level yields. This gap can vary from 10 to 60% in rainfed and flood-prone areas.

CONCLUSION

Agriculture productivity has been significantly impacted by variations in monsoon rainfall amounts. By the end of 2080, the yield of rice might rise by 25% per hectare when rainfall is taken into consideration, according to future yield projection scenarios created using the HadDCM3 model of Meerut Division and the Normalized Yield Deviation (NYD) segregation model. In Western Uttar Pradesh, variations in the maximum temperature are thought to have a significant effect when it comes to wheat output.

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